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(71) Applicant(s)
Freeplay Market Development Limited
(Incorporated in the United Kingdom)
2 Stone Buildings, Lincolns Inn, LONDON, WC2A 3TH, United Kingdom

(72) Inventor(s)
Pierre Becker
John Edward Hutchinson

(74) Agent and/or Address for Service
Beresford & Co
2-5 Warwick Court, High Holborn, LONDON, WC1R 5DH, United Kingdom

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(54) Abstract Title
Handheld generator

(57) A handheld power generator for generating electrical power for a consumer device, comprises a main casing 11, 12 housing an input gear 15 for driving an alternator 17 via at least one intermediate gear 16 so as to provide a step-up drive ratio.

The input gear, intermediate gear, and the rotor of the alternator all have their rotational axes perpendicular to the base of the main casing so that the gears and rotor rotate parallel to the plane of the base.

A rectifier circuit for rectifying the alternator output and a control circuit for modifying the rectifier output to a voltage/current appropriate for the consumer device is provided. The input gear is connected to a drive member 2 rotatable by manual action to rotate the input gear in turn. The axis of the drive member is parallel to the respective axes of the input gear, the intermediate gear and the rotor with all the axes lying in a single straight line.

Alternatively the drive member may comprise a pull cord wound around a bobbin (33, 34 fig.10).

The output of the generator may be used to charge batteries situated in the consumer device (see fig.6).

FIG. 3

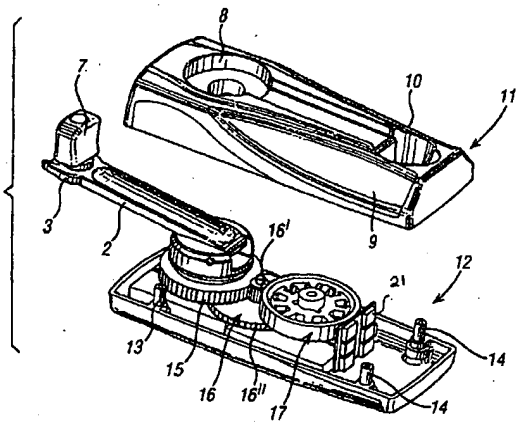

FIGURE 12

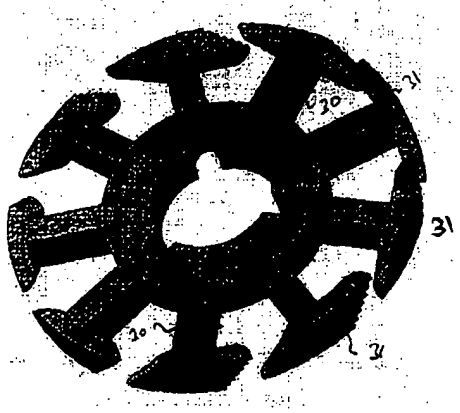

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FIG. 1

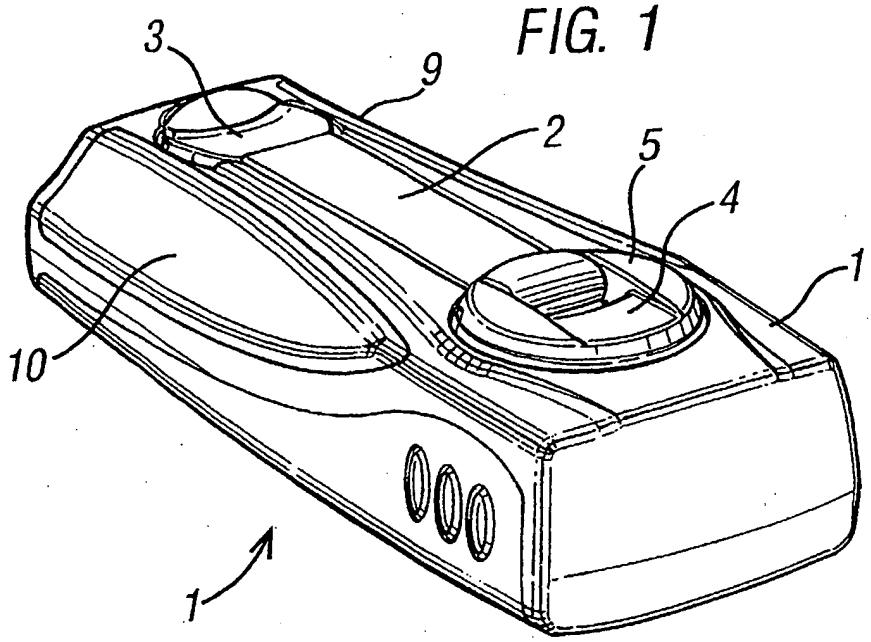
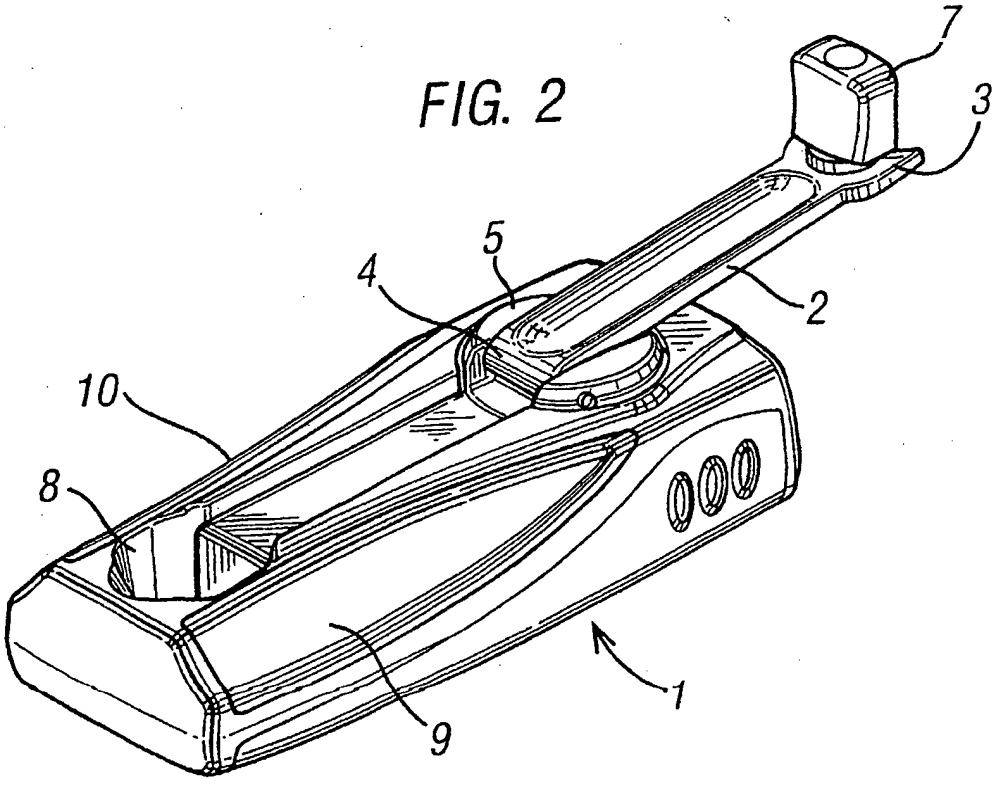


FIG. 2



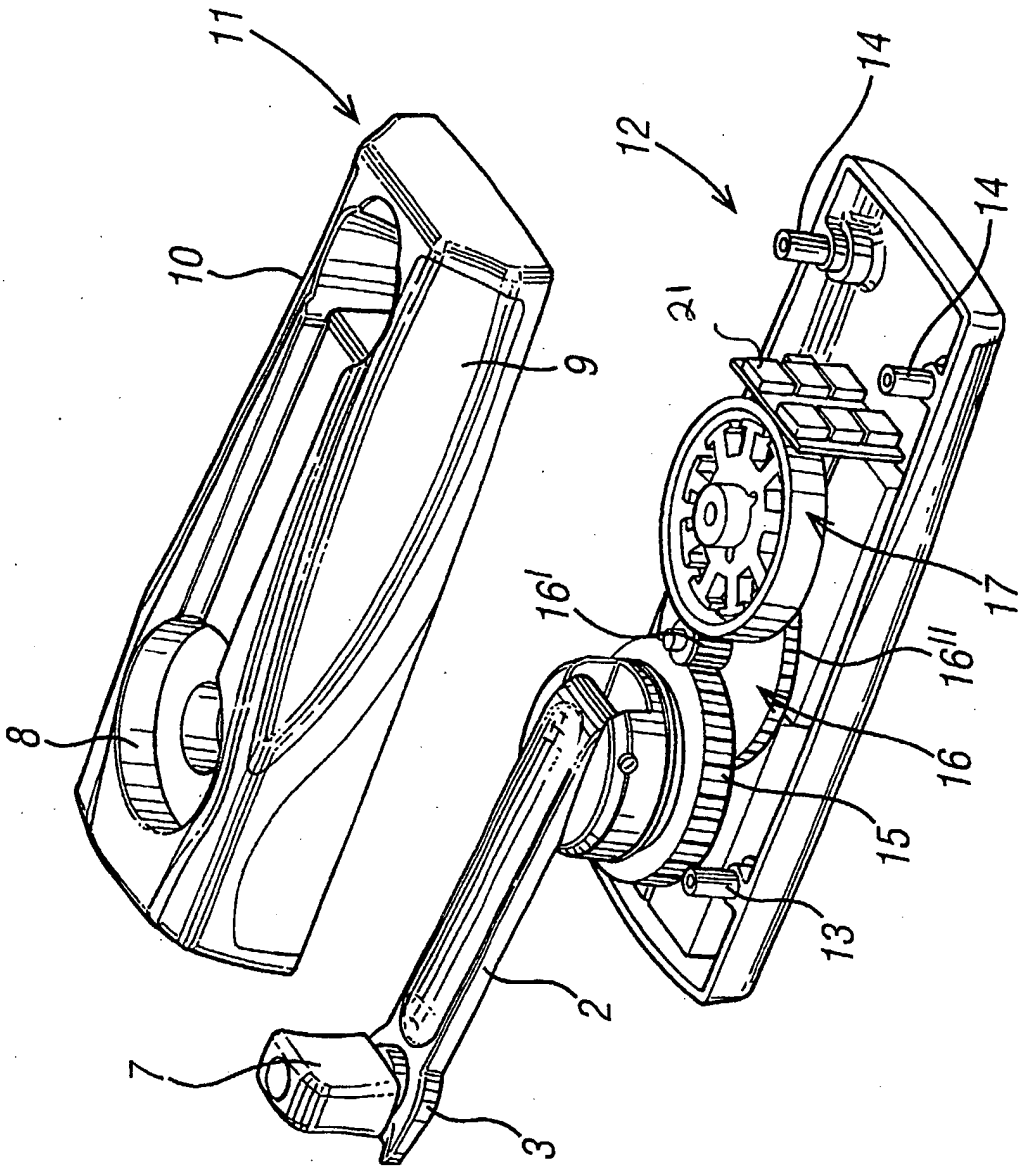


FIG. 3

FIG. 4

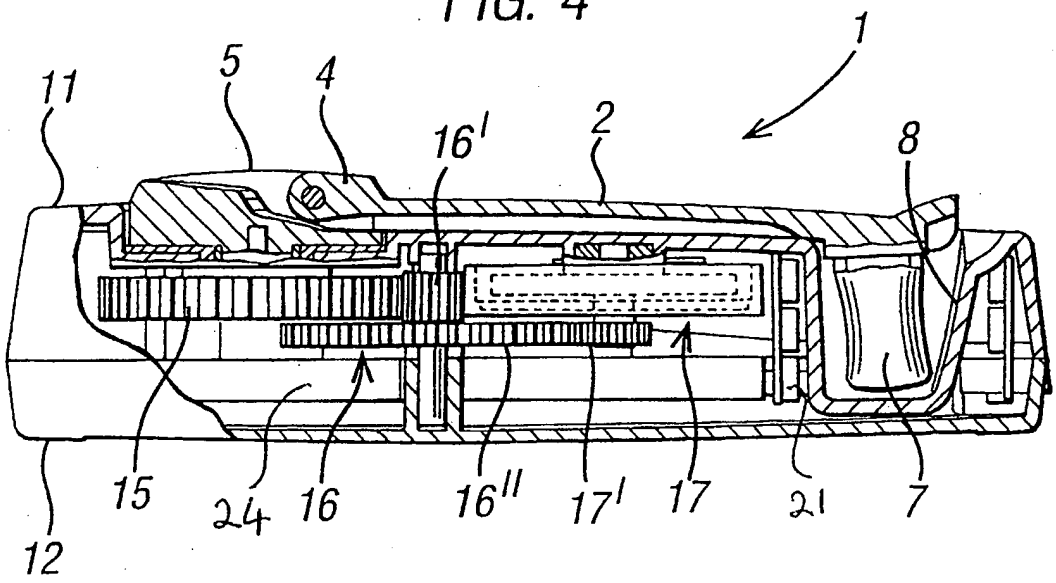
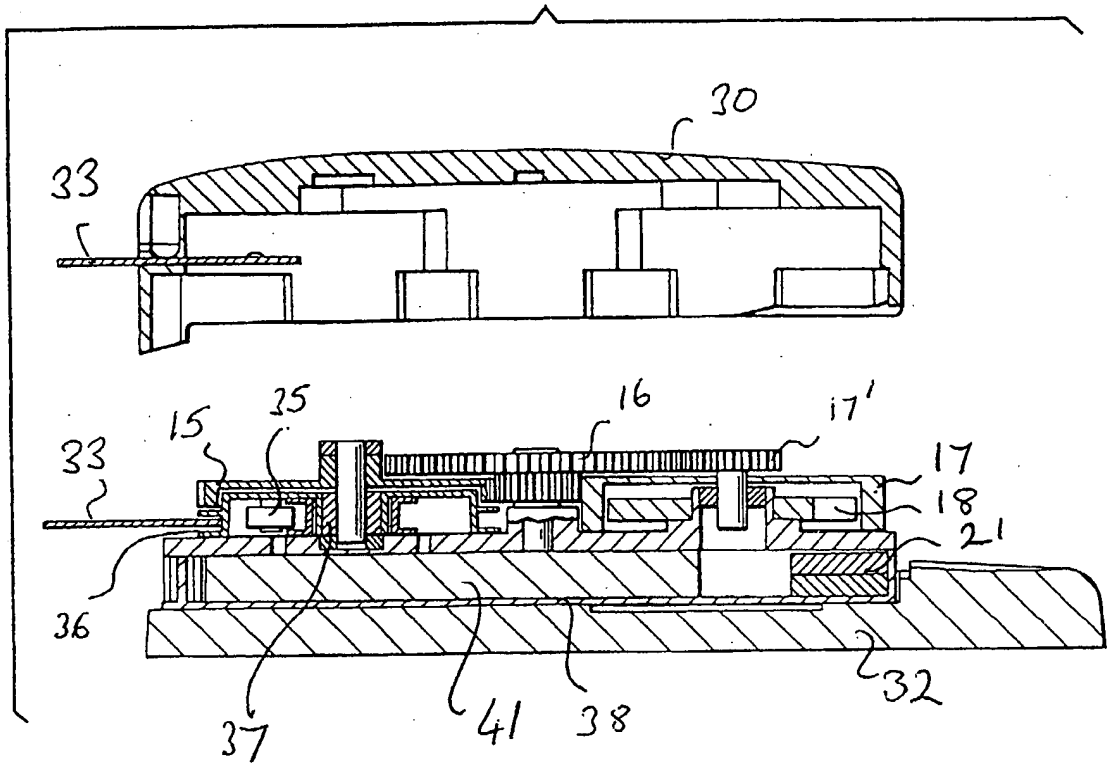

1
11
5
4
16'
2
8
15
24
16
16''
17'
17
21
7
12

FIG. 11


30
33
15
35
16
17'
17
18
21
33
36
37
41
38
32

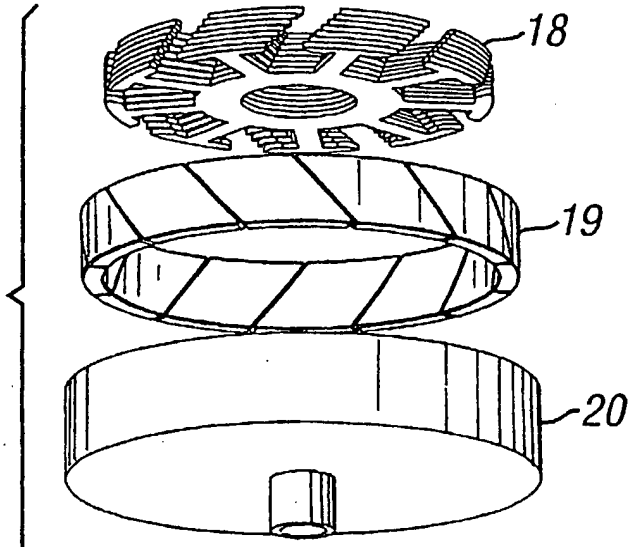

18
19
20

FIG. 5

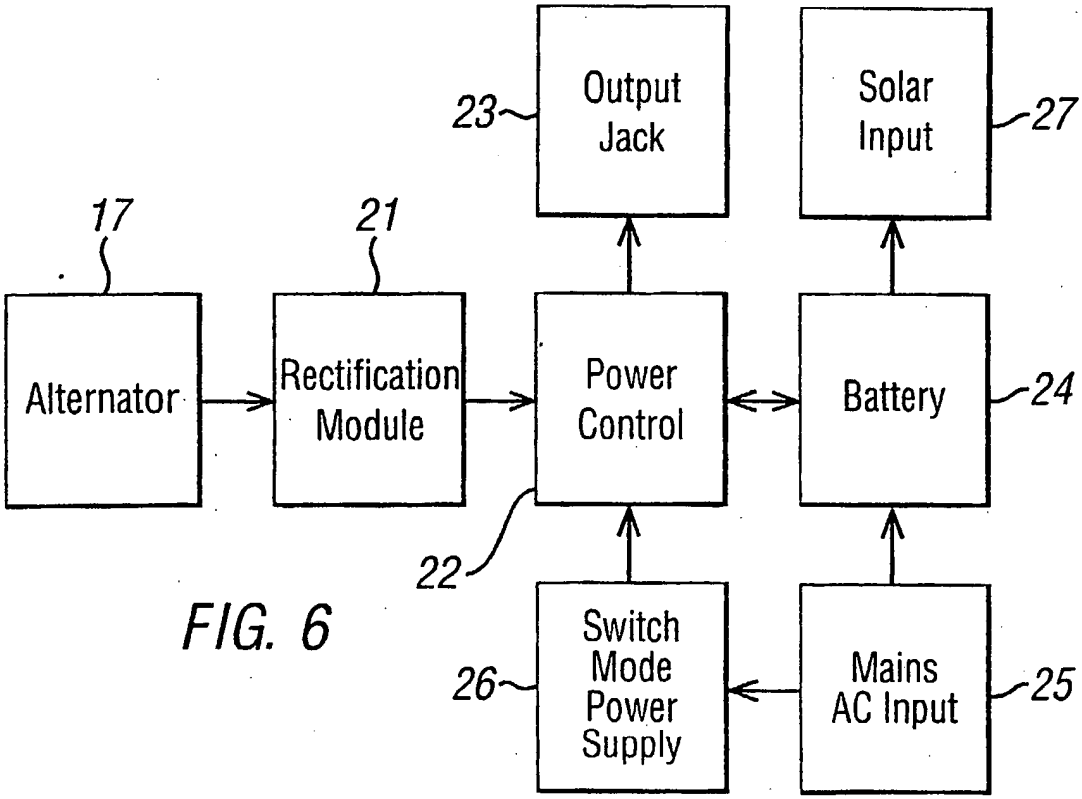

Output Jack
23
Solar Input
27
17
21
Alternator
Rectification Module
Power Control
Battery
24
22
Switch Mode Power Supply
26
Mains AC Input
25

FIG. 6

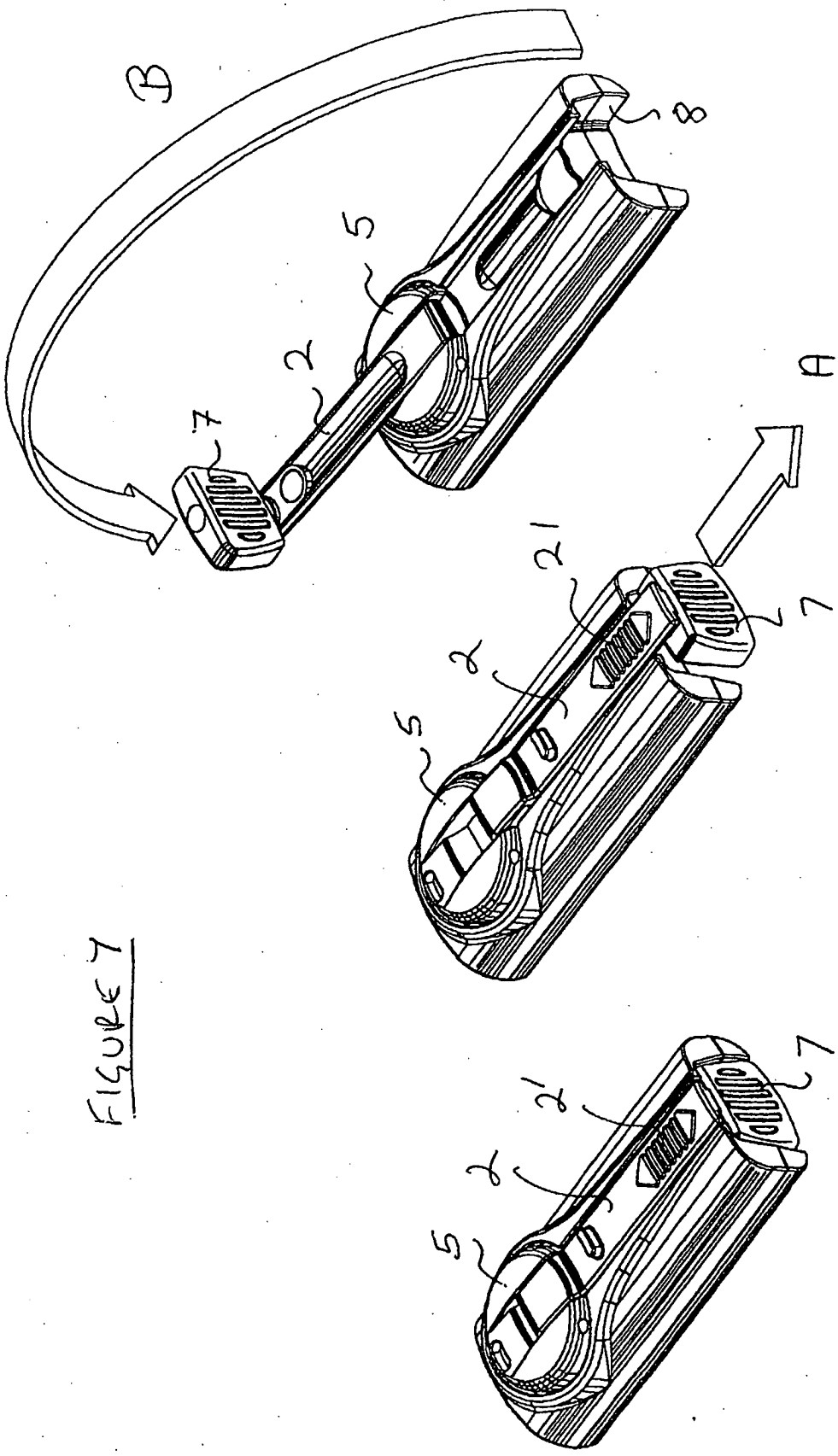


FIGURE 7

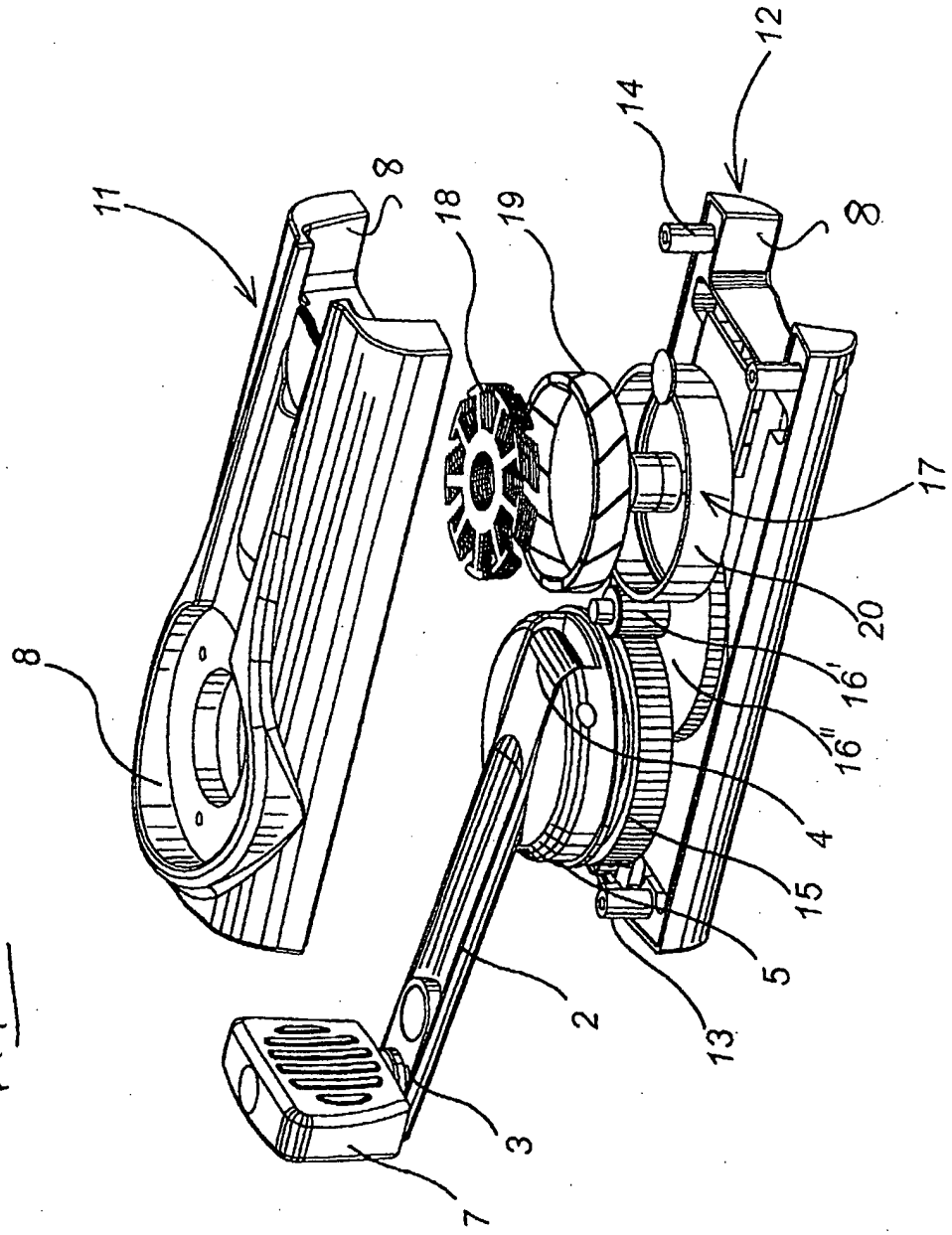


FIGURE 8

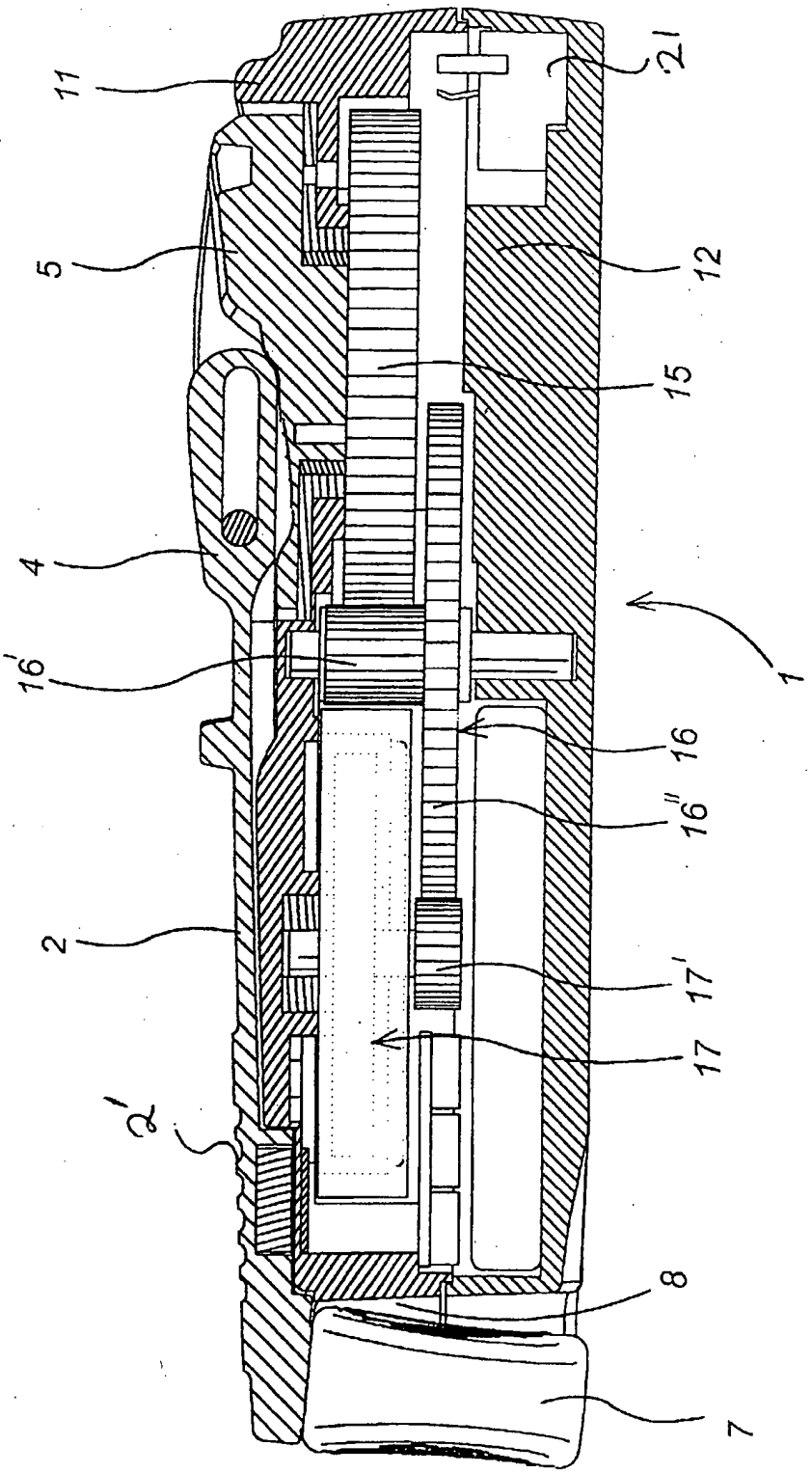


FIGURE 9

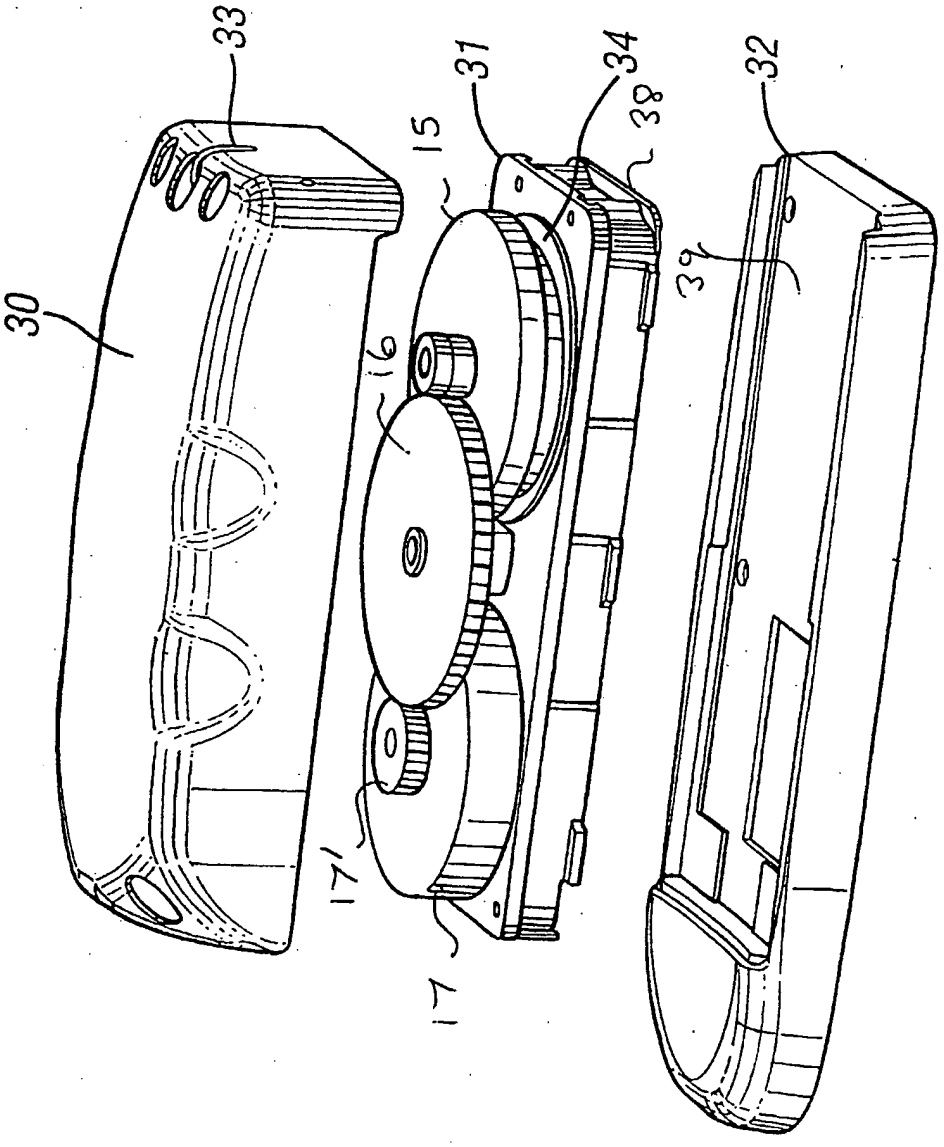


FIG. 10

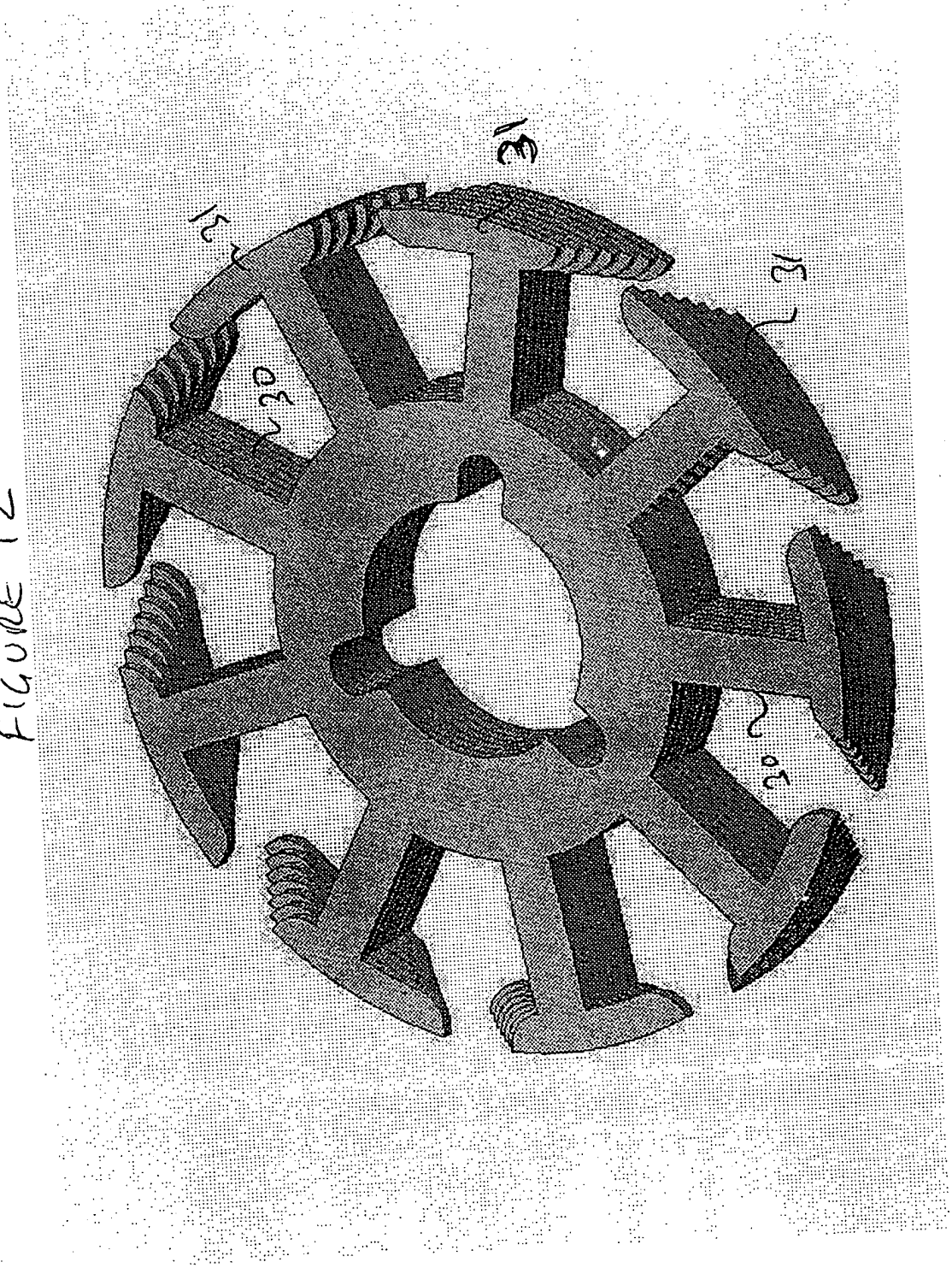


FIGURE 12

HANDHELD GENERATOR

The present invention is concerned with devices by means of which electrical energy can be generated manually. Such devices are already in use in radios but can also find application in cellphones, cordless telephones, two-way radios, PDA's, palm top devices, notebook computers, laptop computers, navigation devices such as GPS receivers, radios, torches, small lanterns, cassette players, CD players, MP3 devices, electronic game devices, fully or partially electrically powered models such as aircraft and cars, emergency equipment such as locator beacons or communication devices, and any other equipment normally using electrical power from batteries.

Such devices can be used to charge the batteries of electronic equipment and also can enable equipment to be used without dedicated batteries. Accordingly a device according to the present invention can be used in a number of ways: firstly, as a replacement for a consumer's standard battery or batteries by using an external power plug on the consumer's device. Secondly, as a replacement for the consumer's standard battery or batteries in which case the device according to the present invention could be a clip-on device. Thirdly, to

charge the battery or batteries of the consumer's equipment through the consumer's charging plug or through the consumer's external power plug if the consumer allows this. Fourthly, to supplement the consumer's battery either through the consumer's charging plug or through the consumer's external power plug.

In accordance with a first aspect of the present invention there is provided a handheld power generator for generating electrical power for a consumer device, the generator comprising a main casing housing an input gear for driving an alternator via at least one intermediate gear so as to provide a step-up drive ratio in the range of;

the input gear, the or each intermediate gear, and the rotor of the alternator all having their rotational axes perpendicular to the base of the main casing so that the gears and rotor rotate parallel to the plane of the base;

a rectifier circuit for rectifying the alternator output;

a control circuit for modifying the rectifier output to a voltage/current appropriate for the consumer device, and wherein the input gear is connected to a drive member rotatable by manual action to rotate the input gear in

turn, the axis of the drive member being parallel to the respective axes of the input gear, the or each intermediate gear and the rotor with all the axes lying in a single straight line, one end of the drive member being pivotally connected to one end of a crank arm which is movable into an operative position from a stored position in which it lies parallel to the base of the casing which with its free end held in a recess in the other end of the casing, the longitudinal axis of the crank arm in its stored position lying orthogonally across the axes of rotation of the gears and the alternator.

In accordance with a second aspect of the present invention there is provided a handheld power generator for generating electrical power for a consumer device, the generator comprising a main casing housing an input gear for driving an alternator via at least one intermediate gear so as to provide a step-up drive ratio in the range of;

the input gear, the or each intermediate gear, and the rotor of the alternator all having their rotational axes perpendicular to the base of the main casing so that the gears and rotor rotate parallel to the plane of the base;

a rectifier circuit for rectifying the alternator output;

a control circuit for modifying the rectifier output to a voltage/current appropriate for the consumer device, and wherein the input gear is connected to a drive member rotatable by manual action to rotate the input gear in turn, the axis of the drive member being parallel to the respective axes of the input gear, the or each intermediate gear and the rotor with all the axes lying in a single straight line, wherein said drive member is a bobbin coupled via a uni-directional clutch to the input gear and having mounted thereon a pull-cord by means of which the bobbin can be rotated to impart drive to the input gear so as to drive the alternator to generate current.

In order that the present invention may be more readily understood, three embodiments thereof will now be described by way of example and with reference to the accompanying drawings.

In the accompanying drawings:

Figures 1 and 2 are perspective views of a standalone accessory in accordance with a first embodiment of the

invention and for providing electric power to a consumer device;

Figure 3 is an exploded perspective view of the accessory of Figures 1 and 2;

Figure 4 is a longitudinal section through the accessory of Figures 1 and 2;

Figure 5 is an exploded perspective view of the alternator of the accessory of Figures 1 and 2;

Figure 6 is a block diagram of a power control circuit;

Figure 7 shows three perspective views of a second embodiment of a stand alone accessory;

Figure 8 is an exploded perspective view of the embodiment of Figure 7;

Figure 9 is a section through the embodiment of Figure 7;

Figure 10 is an exploded perspective view similar to Figures 3 and 8 of a third embodiment of an accessory in accordance with the present invention and for use with a mobile telephone;

Figure 11 is a section through the embodiment of Figure 10; and

Figure 12 is a perspective view of a novel stator for use in the embodiment of the invention.

Turning now to Figure 1 of the accompanying drawings, this shows a standalone accessory having an external casing 1 carrying a folding crank arm 2. The crank arm 2 has a free end indicated at 3 and its other end is pivotally connected at 4 to a crank 5. As can be seen from Figure 2 the pivot 4 enables the crank arm to be pivoted through substantially 180° and has mounted on its free end a small rubberised handle 7. When the crank arm is stowed in its inoperative position the small rubberised handle sits in a socket 8. The main casing 1 is configured so that it can easily be held in one hand by a user so that the crank mechanism can be operated by the user's other hand. In particular the outer casing is provided with two chamfered portions 9 and 10 suitably dimensioned so that they can be easily gripped by the fingers of a user.

For ease of assembly the casing 1 is manufactured in two parts namely a top casing 11 and a bottom casing 12. The

two casing halves are connected by bolts (not shown) passing through cylindrical protrusions 13 and 14 which also act to locate the top casing with respect to the lower casing when they are assembled together.

The length of the crank arm is designed to optimise power input for a particular input speed and the crank 5 itself is mounted on a low friction bearing.

As can be seen from Figures 3 and 4 the crank arm 2 is connected directly to an input gear 15 which transfers the relatively low speed rotation from the crank mechanism to an intermediate gear 16. The input gear 15 has straight cut teeth for high efficiency and as it transfers high torque it also has wide tooth faces.

The intermediate gear 16 receives motion from the input gear via a small diameter gear wheel 16' and transfers motion from the input gear 15 to an alternator assembly generally indicated at 17 via a large diameter gear 16'' which meshes with a small diameter gear 17' of the alternator assembly. Thus the intermediate gear transfers motion from the input gear to the alternator assembly and at the same time increases the relatively low speed input from the input gear 15 to a high speed

output suitable for the alternator. A suitable gearing ratio for this transference is for one rotation of the input gear 15 causes between 20 and 60 rotations of the alternator assembly 17. The choice of the gear ratio is a matter of some importance. The ideal is to have a relative low manual input rpm with high efficiency output from the alternator. A typical input (crank) rpm which can be easily achieved by a user is between 100 and 140rpm. If high power is requested from a small package then a higher gear ratio would be needed. However this can cause problems because of a high initial torque requirement. In the present embodiment the ratio is 30.

The alternator is shown in exploded form in Figure 5 and an alternator stator 18 carrying copper windings which are not shown and an alternator rotor 20 in which are mounted magnet segments 19 which provide the rotor poles. The alternator uses a three phase stator winding with nine stator teeth and twelve rotor poles making in total six pole pairs. It is of course possible that more than three phases may be used. The alternator rotor 20 is in the form of a flattened cup with a boss. The gear 17' is mounted on this boss.

The magnets used in the alternator 17 are a high grade of

neodium-iron-boron (NFeB, or NiB) sintered rare earth magnets. The alternator has a relatively high initial cogging torque, which is multiplied backwards by the transmission ratio, so that an unacceptably high starting torque can result. In order to reduce the effect of this cogging torque both the magnetic pole edges as well as the stator pack in this embodiment are skewed about the alternator axis. It can be seen from Figure 5 that the laminations are identical and that each lamination is angularly skewed with respect to its neighbouring laminations in order to achieve the necessary skewed effect. This also has the secondary effect of smoothing the torque input and giving quiet operation even during high power generation. The alternator rotor 20 is mounted in a sintered brass bush impregnated with very low friction lubricant.

The stator pack 18 is made up of a number of laminations of thin steel so as to reduce eddy currents and their associated losses. Because of this high field strength it is essential to ensure the accurate location of the alternator rotor. Thus the alternator rotor 20 is located axially only by the magnetic field associated with the magnetic circuit formed by the alternator stator, alternator rotor and the magnet segments. Thus it

is not fixed with regard to movement along the axis of its rotation. This ensures that there is no axial bearing loss and locates the alternator rotor automatically in the optimum position for maximum flux density in the stator teeth. The stator axial locating face is machined with the rotor bearing housing in the same operation in order to ensure that the stator and the rotor are properly aligned to avoid out of plane magnetic forces which would increase friction bearing and reduce flux density.

The output of the alternator 17 is taken to a rectification module 21 which houses a three phase rectifier which converts the three phase alternating current power output from the alternator to direct current. If the device is intended to output a high voltage surface mounted Schottky barrier diodes are used for passive rectification. For low voltage devices an active rectification system is used to minimise rectification losses and maximise efficiency. Both these rectification circuits are completely conventional.

Figure 6 of the accompanying drawings is a block diagram indicating the layout of the alternator and the subsequent control circuitry. Thus the output of the

rectification module 21 is supplied to a power control block 22 which is, amongst other factors, essential to perform the conversion from the dc constant voltage from the rectification module to the power format required by the consumer device. Thus the output from the power control block 22 may take a range of formats which may include pulsed voltage, sinusoidal voltage, and current/constant voltage as required. It will be appreciated that each mobile phone company produces mobile phones which have different protocols with regard to the way in which the phones will accept power at the start of and during their operation. The output of the power control block is supplied to an output jack 23 by means of which the device can be connected to a consumer device either directly or via an appropriate cable.

The accessory device which has just been described also includes its own set of batteries and these are shown at 24. These batteries are used as an intermediate energy storage element. This is necessary since most consumer devices will not require the high power output which the alternator delivers, and would typically use and receive energy at a much lower rate. Preferably the battery or batteries is/are either the lithium ion or the lithium polymer types. The lithium ion battery contains no

metallic lithium and has a very high charging power density and can thus accept charging currents of up to five times the amp-hour rating of the battery without negative effects on the safety or life of the battery and at very high efficiencies. The lithium polymer type has similar electrical characteristics to the lithium ion type but can achieve higher energy densities. Additionally the form of this latter type of battery is adaptable to various shapes. Thus it is possible by modifying the shape of the battery to conform to the outer housing so as to provide a particularly compact unit.

Where the battery module contains a plurality of batteries, the power control module can be arranged so that when the batteries are being charged they are charged in series so as to allow a high input voltage and thus more efficient operation of the alternator. Alternatively, when the output of the battery is being used to drive a consumer device the batteries are discharged in parallel at cell voltage which is likely to be a voltage both more suited to the power control module and the consumer device.

Also shown in Figure 6 is a mains ac input 25 by means of

which the battery or batteries can be charged via a switch mode power supply 26 and the power control module 22. In some cases the ac input may be a dc input. Finally, Figure 6 shows in diagrammatic form a solar panel 27 which can also be used to provide a steady charge to the battery or batteries in the battery module. As can be seen this power input does not act via the power control module 22.

Turning now to Figures 7, 8 and 9 of the accompanying drawings it will be seen that these show a hand-held generator very similar in many aspects to the first embodiment.

This second embodiment is particularly concerned with dealing with the conflicting requirements of providing a portable, hand-held generator which is both compact and yet efficient. As the generator largely uses a manual input it will be appreciated that there is a link between efficiency and ease of use and the length of the crank arm by means of which a user imparts drive to the generator.

In the first embodiment the length of the crank arm is limited by the length of the casing as the handle on the

end of the arm has to be stored in a recess in the casing. Thus it is difficult to provide both a crank arm of a length which is ergonomically efficient and a device having a short overall length. This is the problem addressed in the second embodiment.

In Figures 7, 8 and 9 integers which are common to the first embodiment have been given the same reference numerals.

Referring now to Figure 7 the first of the views shows the crank arm 2 in its stored position. The rubberised handle 7 is larger than the handle 7 of the first embodiment and accordingly is also more ergonomically efficient. This increase in size of handle 7 is achieved by providing the end of the main casing 1 with an open-ended recess 8 into which the handle 7 is a clip fit. It will also be seen that the upper surface of crank arm 2 is provided at 2' with a series of ridges. These are intended to provide purchase for a user's fingers. Finally the crank arm 2 is linked to its pivotal connection to the crank 5 via a sliding coupling. This coupling will be described in greater detail hereinafter but by means of the sliding coupling and the ridges 2' the handle 7 can be unclipped from the recess 8 and moved

in the direction of arrow A. The crank arm is then pivoted as shown by arrow B into its operative position in which the ratio of its operative length to the length of casing 1 is greater than the corresponding ratio of the first embodiment.

Referring to Figures 8 and 9 of the accompanying drawings it will be seen that the arrangement of input gear 15, drive gears 16 and alternator 17 are identical to he first embodiment. Additionally the control circuitry of this embodiment is the same as that of the first embodiment as is the battery. Thus these integers together with the battery will not be described further. However in the second embodiment the pivotal coupling is provided by a cross rod 4' mounted on the crank 5 and located in a longitudinal slot in the end of the crank arm 2. In the stored position of the crank arm as shown in Figure 9 the pivot arm abuts the left hand edge of the slot whilst once the crank arm is moved in the direction of arrow A in Figure 7 it will abut the right hand edge of the slot thus providing a useful extension of the crank arm's length.

Turning now to Figure 11 of the accompanying drawings it will be seen that this Figure discloses a third

embodiment of the present invention.

In particular the embodiment of Figure 11 is a clip-on accessory which can be clipped on to a device such as a cellphone so as either to replace the device's normal battery power supply or in fact as to act as the main supply of the consumer device to which it is attached.

Referring now to Figure 11 of the accompanying drawings this shows the third embodiment with its top casing 30 separated from the main body 31 of the device with the operative portion of the device clipped into place on a cellular phone generally indicated at 32.

As with the previous embodiment the device includes an input gear 15 meshing with an intermediate gear 16 in turn driving an alternator assembly 17 via a gear 17'. The construction of the alternator assembly 17 and the associated drive gearing is very similar to that disclosed in the first embodiment so that similar reference numerals are used. Additionally the design of the alternator rotor, magnets and stator winding are the same as that of the previous embodiments except that the stator rotor is inverted. However, in the second embodiment the method by which a user rotates the input

gear 15 is different in that it comprises a pull-cord 33 wound around a bobbin 34 provided with a pair of constant torque springs 35 which act to return the cord into the wound condition after it has been pulled by a user. Only one spring 35 is shown. The two springs are mounted on respective spring posts and a spring-locking collar. Thus the bobbin acts to translate the linear motion of the cord into rotational motion and to house the pull-cord 33. The cord 33 when wound up is housed between spaced circular flanges 36. The bobbin is mounted on a one-way clutch bearing 37 which transmits its motion when rotated by the pull cord to the input gear 15. Preferably the cord is furnished at its free end with a loop which fits around a user's wrist. The input gear 15 meshes with an intermediate gear 16 which in turn drives an alternator gear 17' as in the previous embodiments. In this embodiment the gear ratio between the drive bobbin and the alternator rotor is preferably between 9 and 17. The detailed construction of the rotor and stator of the alternator 17 is identical to that of the alternator of the first embodiment and so will not be described again.

The clip-on accessory is provided with a base plate 38 dimensioned to fit the mounting area on the rear face 39

of the cellphone 32 which would normally receive the cellphone's battery pack. Immediately above this base plate the clip-on accessory houses a battery or batteries 41 which can be of exactly the same type as the batteries described in the first embodiment.

Additionally as with the previous embodiment the clip-on device is provided with a power management module 21 which is similar to that disclosed in the first embodiment but as the clip-on device is designed for a specific phone unit once again the operation of the power management module will be dependent on the nature of power required by the cellphone so that in many instances a simpler power management unit can be employed. In particular the Clip-on unit does not need to follow the charging protocols of the previous embodiments as there is direct access to the phone's own battery.

Referring now to Figure 12 it will be appreciated that a discussion has already been given with regard to the importance of reducing the cogging effect when the generator is initially started. In order to reduce the cogging effect both the stator laminations and the permanent magnets were skewed. It has now been found that the performance of the stator can be improved by not

using identical laminations each of which is angularly displaced with respect to its neighbour. In the stator shown in Figure 12 each stator is provided with stator arms 30 which are identical. However the requisite skewing effect of the stator teeth is provided by varying for each lamination and specifically by varying the teeth of the lamination where are shown at 31. It will be seen that each tooth 31 extends on either side of its stator arm with the input hand extension of the uppermost tooth being substantially longer than the left hand extension. The skewed effect is obtained by progressively reducing the right hand lengths and progressively increasing the left hand lengths. This arrangement enables the copper windings around the arms 30 of the stator to be more effective as the cross-sections of the arms are not skewed so that it is no longer necessary to skew the alternator rotor magnets.

CLAIMS

1. A handheld power generator for generating electrical power for a consumer device, the generator comprising a main casing housing an input gear for driving an alternator via at least one intermediate gear so as to provide a step-up drive ratio in the range of;

the input gear, the or each intermediate gear, and the rotor of the alternator all having their rotational axes perpendicular to the base of the main casing so that the gears and rotor rotate parallel to the plane of the base;

a rectifier circuit for rectifying the alternator output;

a control circuit for modifying the rectifier output to a voltage/current appropriate for the consumer device, and wherein the input gear is connected to a drive member rotatable by manual action to rotate the input gear in turn, the axis of the drive member being parallel to the respective axes of the input gear, the or each intermediate gear and the rotor with all the axes lying in a single straight line, one end of the drive member being pivotally connected to one end of a crank arm which is movable into an operative position from a stored position in which it lies parallel to the base of the casing which with its free end held in a recess in the

other end of the casing, the longitudinal axis of the crank arm in its stored position lying orthogonally across the axes of rotation of the gears and the alternator.

2. A generator according to claim 1, wherein the crank arm is adapted to pivot through approximately 180° from its stored position into its operative position, the length of the crank arm is variable so that its length is greater in the operative position than in the stored position.

3. A generator according to claim 2, wherein the crank arm has at its free end a handle extending transversely from crank arm, and wherein the main casing is provided with a recess in which the handle fits only when the crank arm is in its shortest state.

4. A handheld power generator for generating electrical power for a consumer device, the generator comprising a main casing housing an input gear for driving an alternator via at least one intermediate gear so as to provide a step-up drive ratio in the range of;

the input gear, the or each intermediate gear, and the rotor of the alternator all having their rotational

axes perpendicular to the base of the main casing so that the gears and rotor rotate parallel to the plane of the base;

a rectifier circuit for rectifying the alternator output;

a control circuit for modifying the rectifier output to a voltage/current appropriate for the consumer device, and wherein the input gear is connected to a drive member rotatable by manual action to rotate the input gear in turn, the axis of the drive member being parallel to the respective axes of the input gear, the or each intermediate gear and the rotor with all the axes lying in a single straight line, wherein said drive member is a bobbin coupled via a uni-directional clutch to the input gear and having mounted thereon a pull-cord by means of which the bobbin can be rotated to impart drive to the input gear so as to drive the alternator to generate current.

5. A generator according to claim 3, including a spring biasing the bobbin to the condition in which the draw-cord is stored around the bobbin.

6. A generator according to any preceding claim and including a mounting for at least one rechargeable

battery.

7. A generator according to claim 6, wherein the alternator is adapted to charge the battery through the rectifier and the control circuit.

8. A generator according to claim 6 or claim 7, including a socket whereby the generator can be connected to another outlet so that either the battery or a device can be charged via the generator.

9. A generator according to claim 7 or claim 8 and including at least one solar panel for charging the battery.

10. A generator according to any one of the preceding claims wherein the generator comprises an alternator rotor housing an array of magnets and rotatable with respect to a stator, the stator being formed from a plurality of laminations.

11. A generator according to claim 10 wherein the stator teeth are skewed with respect to the rotation axis of the alternator so as to reduce cogging effects.

12. A generator according to claim 11, wherein the stator laminations each have a plurality of identical stator arms which are aligned with each other, the arms of each stator lamination carrying a tooth portion transverse to the arm, the tooth portion of each stator lamination being different from to the tooth portions of the other stator laminations so that the teeth of the stator formed by the tooth portions are skewed but the stator arms are not.

13. A generator according to any of claims 10, 11 or 12, wherein the alternator rotor is axially located only by the magnetic field associated with the magnetic circuit formed by the stator and the alternator magnets.

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Application No: GB 0031639.8 25/ **Examiner:** Rowland Hunt
Claims searched: All **Date of search:** 22 June 2001

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2302067 A	(GRAHAM)	
A	GB 1421804 A	(WU)	
A	GB 596297 A	(WEINREB)	
A	WO 98/16989 A1	(SONY)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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